(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 332 624 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **02.01.92 Bulletin 92/01**

(51) Int. Cl.[5]: **B03C 3/66**

(21) Application number: **87907361.7**

(22) Date of filing: **29.10.87**

(86) International application number: **PCT/SE87/00509**

(87) International publication number: **WO 88/03057 05.05.88 Gazette 88/10**

(54) **AN ELECTROSTATIC PRECIPITATOR FOR USE IN ELECTROFILTERS.**

(30) Priority: **30.10.86 SE 8604634**

(43) Date of publication of application: **20.09.89 Bulletin 89/38**

(45) Publication of the grant of the patent: **02.01.92 Bulletin 92/01**

(84) Designated Contracting States: **AT BE CH DE FR GB IT LI NL**

(56) References cited:
GB-A- 2 090 547
US-A- 4 477 268

(73) Proprietor: **ASTRAVENT AB**
Arstaängsvägen 1A
S-117 43 Stockholm (SE)

(72) Inventor: **TÖRÖK, Vilmos**
Carl Milles väg 7
S-181 34 Lidingö (SE)
Inventor: **LORETH, Andrzej**
Kommendörsvägen 43
S-184 00 Akersberga (SE)

(74) Representative: **Carminger, Lars**
Carminger, Uusitalo & Nyberg Patentbyra AB
Box 19055
S-104 32 Stockholm (SE)

EP 0 332 624 B1

Description

The present invention relates to an electrostatic precipitator for use in electrostatic filters, so-called electrofilters.

In principle, an electrostatic precipitator comprises a multiple of electrode plates or electrode lamellae which are electrically conductive or semiconductive and which are arranged in mutually spaced parallel relationship and alternatively connected electrically to a respective terminal of a d.c. voltage source, such as to produce a structural device similar to an air capacitor connected to both terminals of the d.c. voltage source. An electrostatic precipitator of this kind is placed in the air flow passage or duct of an electrofilter in a manner such that the electrode plates or lamellae extend transversely across the air duct or air-flow passage in which the filter is placed, with the side surfaces of said plate electrodes parallel with the direction of air flow through the duct. The air flow to be cleansed of aerosol contaminants present in the form of solid particles or liquid droplets is driven through the air-flow duct, and therewith through the precipitator, by means of a blower or fan, natural ventilation, forced draught, or with the aid of an electric ion wind (c.f. International Patent Application PCT/SE85/00538, which corresponds to EP-A-0264363). The electrofilter incorporates upstream of the electrostatic precipitator means for electrically charging the aerosol contaminants present in the air flow in some suitable known manner, e.g. by means of a corona discharge which generates air ions. The purpose of the electrostatic precipitator is therewith to bring the electrically charged contaminants in the air flow passing through the precipitator, between the various plate electrodes thereof, under the influence of the electric field which is generated between adjacent electrodes and which extends essentially at right angles to the direction of air flow, such that the contaminants will migrate to one or the other of said electrodes, depending on the electrical polarity of the contaminants, and fasten on said electrodes, therewith cleansing the air flow from said contaminants.

In order for an electric precipitator of this kind to work with a high degree of efficiency, i.e. to be able to extract a high proportion of the contaminants present in the through-flowing air, it is necessary to generate a high field strength between mutually adjacent electrodes, i.e. small electrode interspacing and a high voltage between mutually adjacent electrodes. These requirements are extremely difficult to achieve, however, with present day electrostatic precipitator constructions. With known electrostatic precipitators, small interspaces and high voltages between mutually adjacent electrodes result in an unacceptable high risk of glow discharge from the electrodes. Such glow discharges occur in particular at the edges of the electrodes, which are normally made of thin sheet metal, and the phenomenon is particularly troublesome when these edges are sharp or irregular, as a result of the method used to manufacture said electrodes, and is heightened still further by the dirt which collects unavoidably on the precipitation electrodes while the precipitator is in use. Such glow discharges give rise to highly disturbing noise levels (crackles and rattles), and also generate ozone in undesirable and at times unacceptable levels. It will also be understood that the precipitation electrodes must be held in position at the required distance apart, in some way or another. When this is achieved with the aid of electrically insulated spacers placed between respective electrodes, the spacers unavoidably become dirty during the use of the precipitator, therewith resulting in the occurrence of creep currents on the dirty surfaces of the spacers. These creep currents gradually destroy the spacer insulation unless a very high quality insulation is used. Consequently, it is normal practice with known electrostatic precipitators of this kind to use relatively complicated, and therewith expensive, constructions in order to avoid, as far as possible the need for electrically insulating spacer elements with short creep current paths.

It will also be understood that an electrostatic precipitator will present a significant capacitance. Consequently, a powerful capacitive discharge current will be released, if the electrodes of the precipitator are touched unintentionally. This current is highly unpleasant and may even be dangerous. Consequently, when electrofilters of this kind are to be used in a human environment, e.g. in domestic environments or working environments, it must be ensured that the electrostatic precipitator cannot be touched unintentionally. This often places on the construction of the electrofilter demands which conflict with other structural desiderata, such as small dimensions, low air-flow resistance, etc.

One object of the invention is therefore to provide an electrostatic precipitator of the kind described in the introduction with which the aforesaid problems and difficulties are overcome, such as to enable a higher voltage and a smaller mutual interspacing to be applied between the adjacent electrodes of said precipitator, thereby achieving a more effective separation of the electrically charged aerosol contaminants from the air flowing through the precipitator or filter than can be achieved with known electrofilters of this kind.

This object is achieved in accordance with the invention in that at least the electrodes connected to one terminal of the d.c. voltage source are connected to said terminal individually, i.e. each per se, instead of being connected directly with one another as with electrostatic precipitators known hitherto. This separate connection of the electrodes or precipitation elements to said one pole is achieved by placing a side-edge part of respective electrodes in pressure

contact with one side of an individual sheet-like or strip-like member which is made of a highly resistive material and which is provided at its point of contact with said electrode with a separate electrical contact means which is connected electrically to the relevant terminal of the d.c. voltage source. An advantage is gained when the remaining electrodes are also connected to the other terminal of the voltage source in a like manner. One terminal of the high voltage source is normally earthed, wherewith at least the electrodes connected to the high voltage terminal of the d.c. voltage source are connected individually and each per se to said source in the afore-described manner.

The aforementioned highly resistive material conveniently consists of a plastic which is highly resistive, so-called antistatic plastic or a plastic treated to become antistatic, for example a plastic material of the kind used to package semi-conductor components so that said components are protected against the effect of electrostatic voltages. Such anti-static, or anti-static treated, plastic materials are available commercially and normally have a surface resistivity of from 10^9-$10^{15}\Omega$, normally in the order of $10^{13}\Omega$.

In accordance with the invention at least the electrodes connected to the one terminal of the d.c. voltage source, namely the non-earthed high voltage terminal of said source, are connected electrically to said terminal and to each other through very high resistances. This means that those currents which are able to occur as a result of electrical discharges from the electrodes or as a result of creep currents along electrically insulating spacer members between adjacent electrodes with differing voltages will be limited to exceedingly small values, e.g. values in the order of 10-100 nA. The aforesaid discharges will therefore be too small and too negligible to generate audible noise or to generate undesirable levels of ozone, while any creep currents that may be generated will be too small to have any deleterious influence on the insulating material. In practice, each electrode of an electrostatic precipitator that is constructed in accordance with the invention will adjust automatically to an individual voltage level in response to extremely moderate discharges and/or extremely low creep currents along the electrically insulating spacer members. Even a direct short circuit between two mutually adjacent electrodes will produce no harmful short-circuit currents, and neither will it affect the voltage level of the remaining electrodes thereby enabling the precipitator to continue to operate practically without interference. The invention also eliminates the possible occurrence of powerful comparitive discharge currents in the event of physical contact with the electrodes, thereby also eliminating the hazards or unpleasantness that such unintentional contact would otherwise cause.

The invention will now be described in more detail with reference to an exemplifying embodiment of an electrostatic precipitator constructed in accordance with the invention and with reference to the accompanying drawing.

The single Figure of the accompanying drawing is a schematic view of the inventive electrostatic precipitator as seen in the direction of air flow through the precipitator or the electrofilter. The air duct in which the precipitator is placed has been omitted from the illustration, for the sake of simplicity and clarity.

The illustrated precipitator is comprised of a plurality of lamellae-like or plate-like electrodes 1 and 2 which are arranged in mutually parallel and mutually spaced relationship, with the side surfaces of the electrodes 1 and 2 extending parallel with the direction of air flow, i.e. at right angles to the plane of the drawing. These electrodes, or precipitation elements, are electrically conductive or semi-conductive. It shall be observed in this regard that the currents to be conducted by the electrodes are very small, since they correspond solely to the electrical charge of the contaminants which precipitate onto the electrodes and to the electrical charge of those air ions which might discharge in the vicinity of the electrodes. The electrodes 1, 2 may therefore be made of metal or constructed from a weakly conductive or semi-conductive material, such as a semi-conductive paper or paperboard construction for example. Each alternate electrode 1, 2 of the precipitator is connected electrically to a respective terminal or pole of a d.c. voltage source 3. In the case of the exemplified preferred embodiment of the inventive electrostatic precipitator, this connection of the precipitation electrodes 1, 2 to a respective one of the two terminals of the voltage source 3 is achieved by bringing one side-edge surface of a respective electrode, or at least parts of said one side-edge surface, into pressure contact with one side of a respective sheet-like or strip-like member 4 or 5 which is made of a highly resistive material, such as a so-called antistatic plastic, or a plastic which has been made antistatic. Such antistatic, or antistatic treated materials are well known per se and are used, inter alia, to wrap semi-conductor components so as to protect the same against electrostatic voltages during the transportation and storage of such components. These plastic materials have a surface resistivity of from 10^9-$10^{15}\Omega$ normally of the order of $10^{13}\Omega$. The antistatic material sold by MAGNAB, Nyköping, Sweden under the designation MPAC has been found extremely suitable to the requirements of the present invention. The plastic members 4, 5 may have a thickness of e.g. 1-5 mm, and will be slightly resilient or elastic, such as to enable the side edges of the electrodes 1, 2 to be held in firm abutment with one side surface of respective plastic members, with the aid of a suitably adapted pressure. The mutually opposing side surfaces of the plastic members 4, 5 have provided thereon respective electrical contact means 6, 7, e.g. in the form of metal wires, metal-

strips, metal plates or the like which are held pressed against the surfaces of respective plastic members and which areconnected electrically to a respective terminal of the d.c. voltage source 3, suitably through a respective high-ohmic resistance 8, 9. An advantage is afforded when the relatively soft and resilient antistatic plastic members 4, 5 are supported in respective rigid holders 10 and 11 made of a good insulating plastic material.

As a result of the arrangement according to the invention, each of the precipitation electrodes 1, 2 is electrically connected individually to its associated terminal of the d.c. voltage source 3, through a very high resistance formed by the respective antistatic plastic-member 4 and 5. In addition to lying between the plate electrodes 1, 2 and associated terminals of the source 3, this high resistance will also lie mutually between the various electrodes 1, 2 which are connected in common to the same terminal of the voltage cource 3. Thus, those electrical discharges which are able to occur at the edges of the electrodes 1, 2 will be limited to such an extent as to be totally inaudible and such as to generate no appreciable amounts of ozone. Similarly, those creep currents which might occur along the electrically insulating spacer members between respective electrodes 1 and 2 will be restricted to such low values as to leave the insulation material unaffected. Furthermore, as a result of the invention, only very low short-circuit currents can occur in the event of a direct short circuit between two mutually adjacent electrodes 1 and 2. In reality each individual electrode 1, 2 will adjust automatically to a voltage level which is contingent on prevailing discharge currents, creeping currents and short-circuit currents through the electrode concerned. A lowering of the voltage level of a given electrode will not affect the voltage levels of the remaining electrodes and will not therfore affect the operation or efficiency of the electrostatic precipitator to any appreciable extent.

The particular construction of the inventive electrostatic precipitator also ensures that no large, dangerous or unpleasant discharge currents can occur as the result of unintentional physical contact with the elctrodes 1, 2.

The primary purpose of the high-ohmic resistances 8, 9 is to prevent the occurrence of large short-circuit currents should one of the plastic members 4, 5 be short-circuited, e.g., as a result of coming into unintentional contact with water.

Normally, one of the terminals of the d.c. voltage source 3 is earthed, as illustrated in the drawing. In the case of an electrostatic precipitator constructed in accordance with the invention it is conceivable to connect this earthed terminal of the d.c. voltage source 3 directly to corresponding precipitation electrodes 2 in a conventional manner. However, it is preferred even in cases such as these to connect the earthed terminal of the voltage source 3 to associated electrodes 2 through a high-resistive antistatic or antistatic-treated plastic member 5, as illustrated in the drawing.

It is beneficial to arrange the precipitation electrodes 1, 2 of an electrostatic precipitator constructed in accordance with the illustrated embodiment such that the distance between the plastic member 4 and the electrodes 2 that are not connected to said member is greater than the mutual distance between mutually adjacent electrodes 1 and 2. Correspondingly, the distance between the plastic member 5 and the electrodes 1 is greater than the mutual distance between mutually adjacent electrodes 1 and 2. This arrangement of the electrodes will prevent a direct spark-over between the electrodes 2 and the plastic member 4, and between the electrodes 1 and the plastic member 5.

The electrodes 1 and 2 are held in position, at the desired distance apart, with the aid of spacer members (not shown) which are made of an electrically insulating material. A great deal of scope is afforded with regard to the configuration and positioning of these spacer members and also in the type of insulating material used herefor, since any creep currents which might travel along the spacer members will be very small and therewith quite harmless, as mentioned in the aforegoing. Thus, the spacer members may be formed from a suitably moldable, electrically insulating resin or glue which is applied at suitable locations between the precipitation electrodes 1 and 2.

Since the precipitation electrodes 1, 2 of the electrostatic precipitator may be formed, e.g., from semi-conductive paper or paperboard, the inventive precipitator can be manufactured readily and at low costs. This enables the precipitator to be intended for one-time use only, i.e. the electrostatic precipitator, or at least the part thereof formed by the electrodes 1, 2, can be discarded and replaced with a new precipitator or a new electrode pack when the old precipitator or electrode pack has become too dirty for effective use.

Claims

1. An electrostatic precipitator for use with electrofilters, comprising a multiple of electrically conductive or semi-conductive plate electrodes or lamella precipitation electrodes (1, 2) which are arranged in mutually parallel and spaced relationship and which are electrically connected alternately to the one terminal and the other terminal of a d.c. voltage source (3), characterized in that at least the electrodes (1 or 2) connected to said one terminal of the voltage source (3) are individually connected to said one terminal by bringing an edge-surface part of a respective electrode (1 or 2) in pressure-contact with one side of a sheet-like or strip-like member (4 or 5) made of a highly resistive material, said highly resistive member

being provided with electrical contact means (6 or 7) which are separate from the locations at which the respective electrodes contact said member and which are connected electrically to the relevant terminal of the d.c. voltage source (3).

2. A precipitator according to Claim 1, characterized in that all electrodes (1, 2) are connected individually to a respective terminal of the d.c. voltage source (3) in the aforesaid manner.

3. A precipitator according to Claim 1 or Claim 2, characterized in that the highly resistive material (4, 5) comprises an antistatic plastic material having a surface resistivity of from 10^9-$10^{15}\Omega$, preferably of ca $10^{13}\Omega$.

4. A precipitator according to Claim 1, characterized in that the terminals of the d.c. voltage source (3) are connected electrically to respective contact means (6 or 7) on respective members (4 or 5) through a high-ohmic resistance (8 or 9).

5. A precipitator according to Claim 1, characterized in that said highly resistive member (4, 5) is slightly resilient or soft.

6. A precipitator according to any of Claims 1-5, characterized in that the electrodes (1, 2) are held in their intended mutual positions with the aid of spacer members comprising an electrically insulating material.

7. A precipitator according to Claim 6, characterized in that the spacer members are formed from a moldable, electrically insulating plastics material or glue.

Patentansprüche

1. Elektrostatischer Entstauber für den Einsatz mit Elektrofiltern, enthaltend eine Vielzahl von elektrisch leitenden oder halbleitenden Plattenelektroden oder Lamellen-bescheideelektroden (1, 2), die parallel in einem Abstand zueinander angeordnet und elektrisch abwechselnd mit der einen Klemme und der anderen Klemme einer GS-Spannungsquelle (3) verbunden sind, **dadurch gekennzeichnet**, daß wenigstens die mit der genannten einen Klemme der Spannungsquelle (3) verbundenen Elektroden (1 oder 2) einzeln an die genannte eine Klemme angeschlossen sind, indem eine Kantenfläche einer entsprechenden Elektrode (1 oder 2) in Druckkontakt mit einer Seite eines folien- oder streifenartigen Elements (4 oder 5) aus einem hochohmigen Material gebracht wird, wobei das genannte hochohmige Element mit elektrischen Kontaktmitteln (6 oder 7) versehen ist, die von den Stellen getrennt sind, an denen die jeweiligen Elektroden mit dem genannten Element in Kontakt stehen, und die elektrisch mit der jeweiligen Klemme der GS-Spannungsquelle (3) verbunden sind.

2. Entstauber nach Anspruch 1, **dadurch gekennzeichnet**, daß sämtliche Elektroden (1, 2) einzeln mit der entsprechenden Klemme der GS-Spannungsquelle (3) auf die oben beschriebene Weise verbunden sind.

3. Entstauber nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, daß das hochohmige Material (4, 5) ein antistatisches Kunststoffmaterial mit einem spezifischen Oberflächenwiderstand von 10^9-$10^{15}\ \Omega$, vorzugsweise von ca. $10^{13}\ \Omega$, enthält.

4. Entstauber nach Anspruch 1, **dadurch gekennzeichnet**, daß die Klemmen der GS-Spannungsquelle (3) über einen Hochohmwiderstand (8 oder 9) elektrisch mit entsprechenden Kontaktmitteln (6 oder 7) an entsprechenden Elementen (4 oder 5) verbunden sind.

5. Entstauber nach Anspruch 1, **dadurch gekennzeichnet**, daß das genannte hochohmige Element (4, 5) etwas elastisch oder weich ist.

6. Entstauber nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet**, daß die Elektroden (1, 2) mit Hilfe von Abstandselementen, die ein elektrisch isolierendes Material enthalten, in den vorgesehenen jeweiligen Positionen gehalten werden.

7. Entstauber nach Anspruch 6, **dadurch gekennzeichnet**, daß die Abstandselemente aus einem verformbaren, elektrisch leitenden Kunststoff oder Leim bestehen.

Revendications

1. Appareil électrostatique de précipitation destiné à être utilisé avec des électrofiltres, comprenant une multiplicité de plaques électrodes ou de lamelles électrodes de précipitation électriquement conductrices ou semi-conductrices (1,2), qui sont disposées parallèlement les unes aux autres et espacées les unes des autres et qui sont électriquement raccordées en alternance à la première borne et à la deuxième borne d'une source de tension continue (3), caractérisé en ce qu'au moins les électrodes (1 ou 2) raccordées à la première borne de la source de tension (3) sont individuellement raccordées à cette borne en amenant une partie de la surface d'un bord d'une électrode respective (1 ou 2) en contact sous pression avec un côté d'un élément analogue à une feuille ou à une bande (4 ou 5) en un matériau extrêmement résistant, cet élément extrêmement résistant étant équipé de moyens de contact électrique (6 ou 7) qui sont séparés des emplacements auxquels les électrodes respectives sont en contact avec cet élément et qui sont raccordés électriquement à la borne correspondante de la source de courant continu (3).

2. Appareil de précipitation selon la revendication 1, caractérisé en ce que toutes les électrodes (1,2) sont raccordées individuellement à une borne respective de la source de tension continue (3) de la manière précitée.

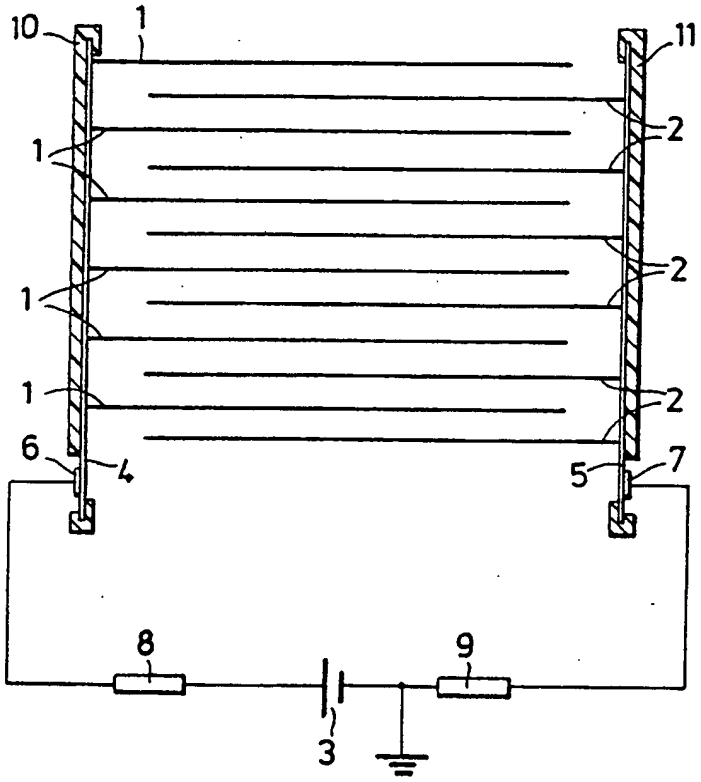
3. Appareil de précipitation selon la revendication 1 ou la revendication 2, caractérisé en ce que le matériau extrêmement résistant (4,5) est une matière plastique antistatique ayant une résistivité de surface comprise entre 10^9 et 10^{15} ohms, de préférence égale à environ 10^{13} ohms.

4. Appareil de précipitation selon la revendication 1, caractérisé en ce que les bornes de la source de tension continue (3) sont raccordées électriquement à des moyens de contact respectifs (6 ou 7) sur des éléments respectifs (4 ou 5) par une résistance ohmique élevée (8 ou 9).

5. Appareil de précipitation selon la revendication 1, caractérisé en ce que cet élément extrêmement résistant (4,5) est légèrement élastique ou tendre.

6. Appareil de précipitation selon l'une des revendications 1 à 5, caractérisé en ce que les électrodes (1,2) sont maintenues dans leurs positions mutuelles prévues à l'aide d'éléments d'espacement constitués par un matériau électriquement isolant.

7. Appareil de précipitation selon la revendication 6, caractérisé en ce que les éléments d'espacement sont formés en une matière plastique ou une colle moulable électriquement isolante.


10
1
11
1
2
1
2
1
2
6
4
5
7
8
9
3